Modelling the impact of COVID-19 pandemic on some Nigerian sectorial Stocks: Evidence from GARCH models with structural breaks

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Abstract

In the past the world stock markets have suffered from Global financial crisis and now the market is been plague by the COVID-19 pandemic of which developed, developing and underdeveloped economies and markets are not left out. Therefore, this study investigates the impact of COVID-19 on five (5) Nigerian Stock Exchange (NSE) sectorial stocks namely: NSE Insurance, NSE Banking, NSE Oil and Gas, NSE Food and Beverages, NSE Consumer goods. To achieve the goal of this paper, daily stock prices were obtained from a secondary source ranging from 2nd January 2020 to 25th March 2021. Because of the importance of incorporating structural breaks in modelling stock returns, the Zivot-Andrews Unit Root Test was applied to the stock returns and the results of the test revealed 20th January 2021, 26th March 2020, 27th July 2020, 23rd March 2020 and 23rd March 2020 as potential break point for NSE Insurance, NSE Food, Beverages and Tobacco, NSE Oil and Gas, NSE Banking and NSE Consumer goods respectively. This study investigates the volatility in daily stock returns for the five (5) Nigerian Stock Exchange (NSE) sectorial stocks using nine variants of GARCH models: sGARCH, girGARCH, eGARCH, iGARCH, aPARCH, TGARCH, NGARCH, NAGARCH, and AVGARCH along with the half-life and persistence values were obtained. The study used the Student t and Skewed Student t distributions. The results from the GARCH models revealed negative impact of COVID-19 on NSE Insurance, NSE Food, Beverages and Tobacco, NSE Banking and NSE Consumer goods stock returns except NSE Oil and Gas returns which showed positive correlation with the COVID-19 Pandemic. This study recommends shareholders; investors and policy players in the Nigerian Stock exchange markets should be adequately prepared in form of diversification of investment in stocks that can withstand future possible crisis in the market.

Keywords: COVID-19, NSE, GARCH, Structural breaks, Persistence, Half-life

1. Introduction

The stock market being a major component in the financial sector of most developing countries such as Nigeria that serves a pivotal role in the development and contribution to economic growth through diversification and possible pooling of savings from different investors and availing them to companies for optimal utilization. In the past the world stock markets have suffered from Global financial crisis and now the market is been plague by the COVID-19 pandemic of which developed, developing and underdeveloped economies and markets are not left out.

Recent works on impact covid-19 on Nigeria stock market and economy are as follows:
Ozili and Arun (2020) studied the impact of COVID-19 on the global economy and reveal that COVID-19 have a huge negative impact on Nigeria stock market. Akanni and Gabriel (2020) investigated the Implication of COVID-19 on the Nigerian Economy, it was discovered that covid-19 pandemic lead to disruption of economic activities and leads to economy instability. Adenomon et al. (2020) studied the effects of COVID-19 outbreak on the Nigerian Stock Exchange performance using GARCH Models. The results revealed a loss in stock returns and high volatility in stock returns under the COVID-19 period in Nigeria as against the normal period under study. In addition, Quadratic GARCH (QGARCH) and Exponential GARCH (EGARCH) models with dummy variable were applied to the stock returns shows that the COVID-19 has had negative effect on the stock returns in Nigeria. Albulesu (2020) noted that the pre-pandemic phase of COVID-19 has severely affected the real economy, with a negative impact on trade, tourism and transport industry, generating local food shortages. Sansa (2020) examined the impact of the COVID-19 on the financial markets with evidence from China and USA using simple regression model on data spanning 1st March 2020 to 25th March 2020 in China and USA. The findings revealed a positive significant relationship between the COVID-19 confirmed cases and the financial markets. Haroon and Rizvi (2020) analyzed the relationship between sentiment generated by COVID-19 related news and volatility of equity markets. The study revealed that panic generated by the news outlets regarding COVID-19 are associated with increasing volatility in the equity markets. Zhang et al. (2020) considered the financial markets under the global pandemic of COVID-19 using daily data up to 27th March 2020 for certain countries. The study implemented the volatility analysis, correlation analysis and minimum spanning tree. Their work confirmed that market risks have increased substantially in response to the pandemic, individual stock market

reactions are linked to the severity of the outbreak of the pandemic. Albulesu (2021) investigated the impact of COVID-19 pandemic uncertainty on the financial market volatility with interest to new infection cases and the fatality ratio reported at the global level and in the US. S&P 500 3-month realized volatility index was used as proxy for the US financial markets volatility while the test of simple Ordinary Least Squares (OLS) and the stepwise procedure were implemented. They study concluded that the persistence of COVID-19 crisis and its related uncertainty, amplifies the US financial markets volatility, affecting thus the global financial circle.

Other previous studies include Ashraf (2020) investigated the economic impact of government interventions during COVID-19 pandemic in relation to international evidence from financial markets; Wei and Han (2021) studied the impact of COVID-19 pandemic on transmission of monetary policy to financial markets.

From the foregoing, much work have not paid attention on the sectorial stocks of the Nigerian Stock Exchange. Hence this study investigates the impact of COVID-19 on five (5) Nigerian Stock Exchange (NSE) sectorial stocks namely: NSE Insurance, NSE Banking, NSE Oil and Gas, NSE Food and Beverages, NSE Consumer goods using nine variants of GARCH models: sGARCH, girGARCH, eGARCH, iGARCH, aPARCH, TGARCH, NGARCH, NAGARCH, and AVGARCH along with the half-life and persistence values were obtained

2. Methodology

A. Variants of GARCH Models

2.1 Standard GARCH(p,q) Model

$$a_t = \sigma_t \varepsilon_t, \qquad \sigma_t^2 = \omega + \sum_{i=1}^{p} \alpha_i a_{t-i}^2 + \sum_{j=1}^{q} \beta_j \sigma_{t-j}^2 \tag{1}$$

The GARCH(1,1) model given by

$$a_t = \sigma_t \varepsilon_t, \qquad \sigma_t^2 = \omega + \alpha_1 a_{t-1}^2 + \beta_1 \sigma_{t-1}^2 \tag{2}$$

2.2 Asymmetric Power ARCH

$$\sigma_t^\delta = \omega + \sum_{i=1}^{p} \alpha_i (|a_{t-i}| - \gamma_i a_{t-i})^\delta + \sum_{j=1}^{q} \beta_j \sigma_{t-j}^\delta \tag{3}$$

2.3 GJR-GARCH(p,q) Model

The Glosten-Jagannathan-Runkle GARCH (GJRGARCH) model

$$\sigma_t^2 = \omega + \sum_{i=1}^{p} \alpha_i (1-\gamma_i)^2 \varepsilon_{t-i}^2 + \sum_{j=1}^{q} \beta_j \sigma_{t-j}^2 + \sum_{i=1}^{p} \gamma_i^* S_i^- \varepsilon_{t-i}^2 \quad (4)$$

which is the GJRGARCH model (Rossi, 2004).

2.4 IGARCH(1,1) Model

Integrated GARCH (IGARCH) models are unit-root GARCH models. The IGARCH(1,1) model is specified in Tsay (2005) as

$$a_t = \sigma_t \varepsilon_t;$$

$$\sigma_t^2 = \alpha_0 + \beta_1 \sigma_{t-1}^2 + (1-\beta_1) a_{t-1}^2 \quad (5)$$

2.5 TGARCH(p,q) Model

The threshold GARCH model is another model used to handle leverage effects, and a TGARCH(p,q) model is given by the following: The TGARCH(1,1) model becomes:

$$\sigma_t^2 = \omega + (\alpha + \gamma N_{t-1}) a_{t-1}^2 + \beta \sigma_{t-1}^2 \quad (6)$$

2.6 NGARCH(p,q) Model

The nonlinear GARCH model is presented as

$$\sigma_t = \omega + \sum_{i=1}^{q} \alpha_i \varepsilon_{t-i}^2 + \sum_{i=1}^{q} \gamma_i \varepsilon_{t-i} + \sum_{j=1}^{p} \beta_j \sigma_{t-j} \quad (7)$$

2.7 EGARCH Model

The exponential GARCH (EGARCH) model was proposed by Nelson (1991) to overcome some weaknesses of the GARCH model in handling financial time series.

EGARCH(1,1) being written as

$$a_t = \sigma_t \varepsilon_t$$

$$\ln(\sigma_t^2) = \omega + \alpha([|a_{t-1}| - \mathrm{E}(|a_{t-1}|)]) + \theta a_{t-1} + \beta \ln(\sigma_{t-1}^2) \quad (8)$$

2.8 AVGARCH Model

The absolute value GARCH (AVGARCH) model is specified as

$$a_t = \sigma_t \varepsilon_t \ ;$$

$$\sigma^2 = \omega + \sum_{t=1}^{p} \alpha_i (|\varepsilon_{t-i} + b| - c(\varepsilon_{t-i} + b))^2 + \sum_{j=1}^{q} \beta_j \sigma_{t-j}^2 \quad (9)$$

2.9 N(A)GARCH or NAGARCH Model

The nonlinear (asymmetric) GARCH (NAGARCH or N(A)GARCH) model plays key role in option pricing with stochastic volatility . NAGARCH may be written as

$$\sigma_{t+1}^2 = \omega + \alpha \sigma_t^2 (z_t - \delta)^2 + \beta \sigma_t^2 \quad (10)$$

B. Persistence and Half-life Volatility

Persistence refers to the low or high persistency in volatility exhibited by financial time series can be determined by the GARCH coefficients of a stationary GARCH model. The persistence of a GARCH model can be calculated as the sum of GARCH (β_1) and ARCH (α_1) coefficients that is $\alpha + \beta_1$. In most financial time series, it is very close to one (1) (Banerjee & Sarkar 2006; Ahmed *et al*. 2018). Persistence could take the following conditions:

If $\alpha + \beta_1 < 1$: The model ensures positive conditional variance as well as stationary.

If $\alpha + \beta_1 = 1$: we have an exponential decay model, then the half-life becomes infinite. Meaning the model is strictly stationary.

If $\alpha + \beta_1 > 1$: The GARCH model is said to be non-stationary, meaning that the volatility ultimately detonates toward the infinitude (Ahmed *et al*. 2018). In addition, the model shows that the conditional variance is unstable, unpredicted and the process is non-stationary (Kuhe 2018).

Half-life volatility measures the mean reverting speed (average time) of a stock price or returns. The mathematical expression of half-life volatility is given as

$$Half - Life = \frac{\ln(0.5)}{\ln(\alpha_1 + \beta_1)} \tag{11}$$

It can be noted that the value of $\alpha + \beta_1$ influences the mean reverting speed (Ahmed *et al*. 2018), which means that if the value of $\alpha + \beta_1$ is closer to one (1), then the volatility shocks of the half-life will be longer.

C. Distributions of GARCH models

In this study we employed two innovations namely student t and skewed student t distributions they can account for excess kurtosis and non-normality in financial returns (Heracleous 2003; Wilhelmsson 2016; Kuhe 2018).

The student t distribution is given as

$$f(y) = \frac{\Gamma\left(\frac{v+1}{2}\right)}{\sqrt{v\pi}\,\Gamma\left(\frac{v}{2}\right)}\left(1 + \frac{y^2}{v}\right)^{-\frac{(v+1)}{2}}; \qquad -\infty < y < \infty \tag{12}$$

The Skewed student t distribution is given as

$$f(y;\ \mu, \sigma, \nu, \lambda) = \begin{cases} bc\left(1 + \frac{1}{\nu-2}\left(\frac{b\left(\frac{y-\mu}{\sigma}\right)+a}{1-\lambda}\right)^2\right)^{-\frac{\nu+1}{2}}, & if\ y < -\frac{a}{b} \\ bc\left(1 + \frac{1}{\nu-2}\left(\frac{b\left(\frac{y-\mu}{\sigma}\right)+a}{1+\lambda}\right)^2\right)^{-\frac{\nu+1}{2}}, & if\ y \geq -\frac{a}{b} \end{cases} \tag{13}$$

Where ν is the shape parameter with $2 < \nu < \infty$ and λ and is the skewness parameter with $-1 < \lambda < 1$. The constants $a, b\ and\ c$ are given as

$$a = 4\lambda c\left(\frac{\nu-2}{\nu-1}\right);\ b = 1 + 3(\lambda)^2 - a^2;\ c = \frac{\Gamma(\frac{\nu+1}{2})}{\sqrt{\pi(\nu-2)\Gamma(\frac{\nu}{2})}}. \tag{14}$$

Where μ and σ are the mean and standard deviation of the skewed student *t* distribution respectively.

3. Materials and Methods

Daily stock prices were obtained from a secondary source ranging from 2nd January 2020 to 25th March 2021. Nigerian Stock Exchange (NSE) sectorial stocks namely: NSE Insurance, NSE Banking, NSE Oil and Gas, NSE Food and Beverages, NSE Consumer goods were collected from www.investing.com. The structural break was coded as 0 for period before the break and 1 for period of the break upward.

The returns were calculated using the following formula:

$$R_t = \ln P_t - \ln P_{t-1} \tag{15}$$

where R_t is return at time t; ln is the natural logarithm; P_t is the current daily stock price at time t, and P_{t-1} is the previous daily stock price at time $t-1$. This study employed the student t distribution and skewed student t distribution.

4 Results and Discussion

The analyses of this study were carried in R environment using rugarch package by Ghalanos (2018).

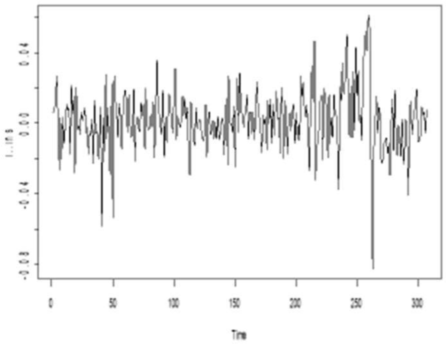

Fig. 1: Plot of returns of NSE Insurance

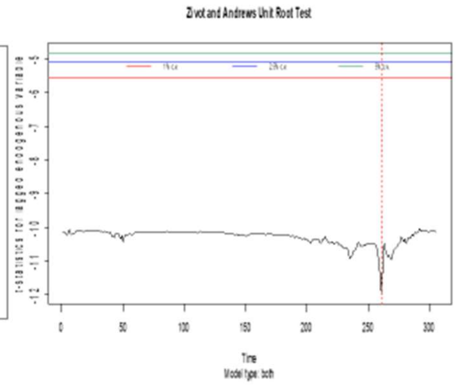

Fig. 2: Plot of Zivot and Andrews Unit root test of returns of NSE Insurance

The Fig. 1 shows some evidence of volatility but a sharp drop at data point 261 which is evidence of break

The Fig. 2 shows that the return series is stationary with a potential break point at 261 (20th January 2021)

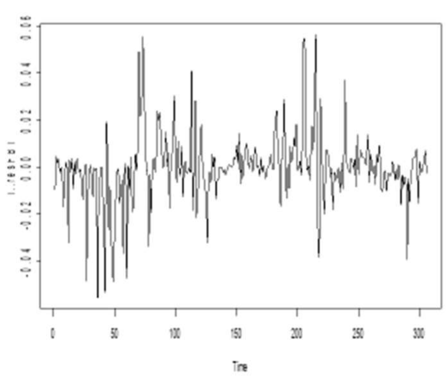

Fig. 3: Plot of returns of NSE Food, Beverages and Tobacco

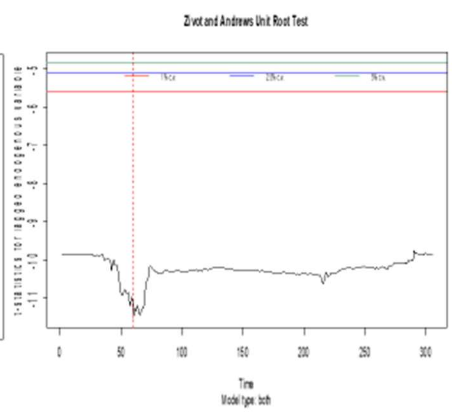

Fig. 4: Plot of Zivot and Andrews Unit root test of returns of NSE Food, Beverages and Tobacco

The Fig. 3 shows some evidence of volatility at the beginning of the return series but a sharp drop at data point 60 which is evidence of break

The Fig. 4 shows that the return series is stationary with a potential break point at 60 (26th March 2020)

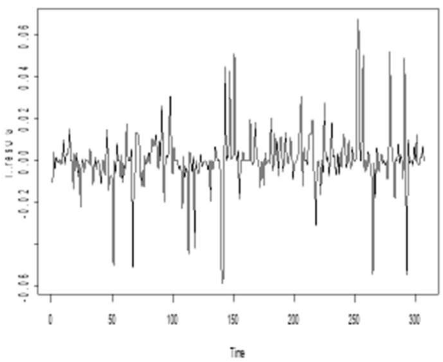

Fig. 5: Plot of returns of NSE Oil and Gas

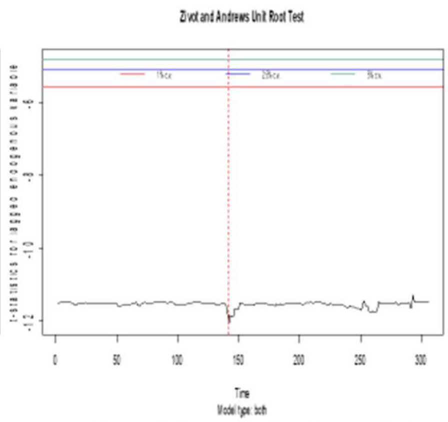

Fig. 6: Plot of Zivot and Andrews Unit root test of returns of NSE Oil and Gas

The Fig. 5 shows some evidence of volatility at the mid of the return series but a sharp drop at data point 142 which is evidence of break

The Fig. 6 shows that the return series is stationary with a potential break point at 142 (27th July 2020)

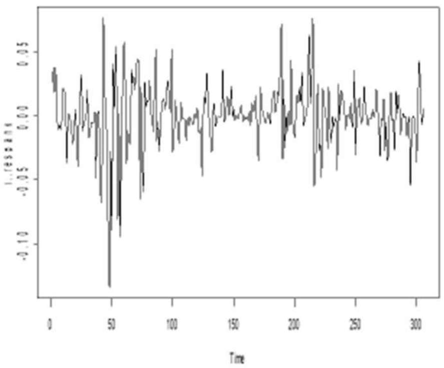

Fig. 7: Plot of returns of NSE Banking

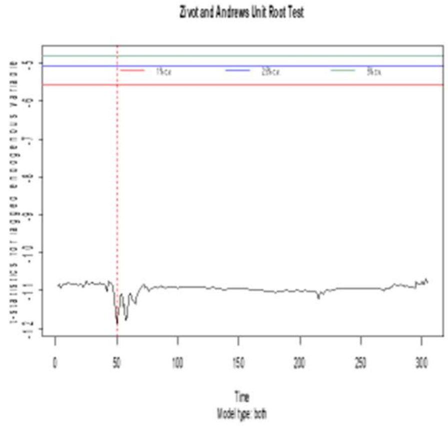

Fig. 8: Plot of Zivot and Andrews Unit root test of returns of NSE Banking

The Fig. 7 shows some evidence of volatility at the beginning of the return series but a sharp drop at data point 50 which is evidence of break

The Fig. 8 shows that the return series is stationary with a potential break point at 50 (23rd March 2020)

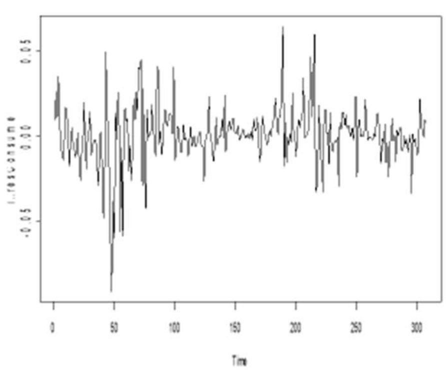

Fig. 9: Plot of returns of NSE Consumer goods

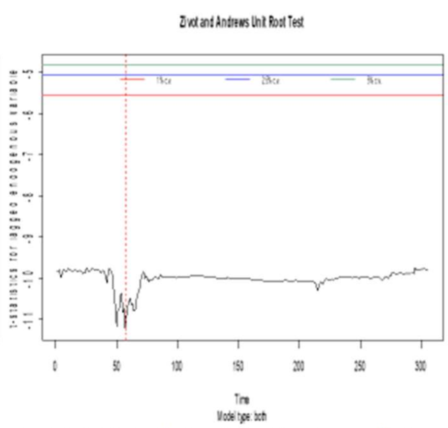

Fig. 10: Plot of Zivot and Andrews Unit root test of returns of NSE Consumer goods

The Fig. 9 shows some evidence of volatility at the beginning of the return series but a sharp drop at data point 57 which is evidence of break

The Fig. 10 shows that the return series is stationary with a potential break point at 57 (23rd March 2020)

Table 1. Descriptive Statistics

	Insurance	Food and Bevarages	Oil and Gas	Banking	Consumer goods
min: max: median: mean: standard-dev skewness: kurtosis: J-B Test	-0.0826 0.06104 0.00236 0.0015 0.0176 -0.3161 6.135866 Chi-squared: 125.2742 p Value: < 2.2e-16	-0.0554 0.0565 -0.0002 -0.0003 0.0148 0.0970 7.5910 Chi-squared: 258.2982 p Value: < 2.2e-16	-0.0587 0.06747 0 0.0002 0.0145 -0.0425 10.27226 Chi-squared: 651.2702 p Value: < 2.2e-16	-0.1339 0.0769 -0.0003 4.2941e-05 0.0252 -0.8527 7.4399 Chi-squared: 277.7695 p Value: < 2.2e-16	-0.0908 0.0637 0.0003 0.0003 0.0172 -0.6472 8.0291 Chi-squared: 331.875 p Value: < 2.2e-16
Test statistic:	-11.9886	-11.5032	-12.0659	-11.9441	-11.2705
Critical value	-5.08	-5.08	-5.08	-5.08	-5.08
Breakpoint	261 (20th January 2021)	60 (26th March 2020)	142 (27th July 2020)	50 (23rd March 2020)	57 (23rd March 2020)
Arch Test (lag 15)	Chi-squared = 74.761, df = 15, p-value = 6.253e-10	Chi-squared = 36.051, df = 15, p-value = 0.001738	Chi-squared = 30.743, df = 15, p-value = 0.009507	Chi-squared = 88.179, df = 15, p-value = 2.166e-12	Chi-squared = 85.276, df = 15, p-value = 7.481e-12

The return series are not normally distributed and series exhibited evidences of Arch effects. Which shows the appropriateness of application of GARCH models. The Zivot-Andrews Unit Root Test was applied to the stock returns and the results of the test revealed 20th January 2021, 26th March 2020, 27th July 2020, 23rd March 2020 and 23rd March 2020 as potential break point for NSE Insurance, NSE Food, Beverages and Tobacco, NSE Oil and Gas, NSE Banking and NSE Consumer goods respectively

Table 2. Results of NSE Insurance returns

	Insurance					
	Std			Skewed std		
Models	AIC	Half-Life	persistence	AIC	Half-Life	persistence
sGARCH(1,1)	-5.430249	4.700756	0.8629018	-5.433678	4.685996	0.8625011
gjrGARCH (1,1)	-5.434756	3.320903	0.8116204	-5.440714	3.933909	0.8384519
eGARCH (1,1)	-5.435603	5.540889	0.8824115	-5.443353	6.159152	0.8935622
apARCH(1,1)	-5.438118	3.227181	0.8067156	-5.443518	3.653911	0.8272072

iGARCH(1,1)	-5.423510	-Inf	1.0000000	-5.430062	-Inf	1.0000000
TGARCH(1,1)	-5.443094	3.187461	0.8045593	-5.449578	3.700418	0.8291817
NGARCH(1,1)	-5.415279	7.247415	0.9087906	-5.419009	10.795367	0.9378101
NAGARCH (1,1)	-5.434218	3.419928	0.8165404	-5.440077	4.250878	0.8495404
AVGARCH(1,1)	-5.436992	3.218895	0.8062697	-5.443787	3.908028	0.8374741

TGARCH(1,1) model has the least AIC value for both student t and skewed student t distribution. The model is stable while the mean reverting takes average of 4 days. With the TGARCH(1,1) the effect of covid-19 is positively correlated while with EGARCH(1,1) the effect of covid-19 is negatively related though not significant in both models.

Table 3. Results of NSE Food, Beverages and Tobacco

	Food, Beverages and Tobacco					
	Std			Skewed std		
	AIC	Half-Life	persistence	AIC	Half-Life	persistence
sGARCH(1,1)	-6.187684	-1.736062	1.4907273	-6.181459	-1.711531	1.4992826
gjrGARCH (1,1)	-6.191418	-1.719803	1.4963648	-6.184810	-1.712649	1.4988863
eGARCH (1,1)	-6.204170	11.631495	0.9421486	-6.198026	12.052532	0.9441120
apARCH(1,1)	-6.177988	NA	NA	-6.179059	NA	NA
iGARCH(1,1)	-6.178557	-Inf	1.0000000	-6.172347	-Inf	1.0000000
TGARCH(1,1)	-6.181729	12.360041	0.9454638	-6.175283	12.299470	0.9452027
NGARCH(1,1)	-6.182122	NA	NA	-6.176249	NA	NA
NAGARCH (1,1)	-6.192942	-2.572041	1.3093005	-6.184288	-4.106239	1.1838874
AVGARCH(1,1)	-6.173895	13.416227	0.9496471	-6.174778	13.949783	0.9515255

EGARCH(1,1) model has the least AIC value for both student t and skewed student t distribution. The model is stable while the mean reverting takes average of 12 days. The effect of covid-19 is negatively correlated with the returns and significant ($p<0.05$) for model with student t distribution and not significant with skewed student t distribution.

Table 4. Results of NSE Oil and Gas

	Oil and Gas					
	Std			Skewed std		
	AIC	Half-Life	persistence	AIC	Half-Life	Persistence
sGARCH(1,1)	-6.407924	19.71041	0.9654446	-6.402832	25.74334	0.9734340
gjrGARCH (1,1)	-6.414883	16.54482	0.9589704	-6.401627	28.62948	0.9760798
eGARCH (1,1)	-6.47725	20.33172	0.9664827	-6.495382	12.72524	0.9469867
apARCH(1,1)	-6.395022	NA	NA	-6.398517	NA	NA
iGARCH(1,1)	-6.401054	-Inf	1.0000000	-6.395362	-Inf	1.0000000
TGARCH(1,1)	-6.400915	13.02266	0.9481655	-6.395914	12.42958	0.9457605
NGARCH(1,1)	-6.411548	NA	NA	-6.401687	NA	NA
NAGARCH (1,1)	NA	NA	NA	-6.401862	23.18114	0.9705413
AVGARCH(1,1)	NA	NA	NA	NA	NA	NA

EGARCH(1,1) model has the least AIC value for both student t and skewed student t distribution. The model is stable while the mean reverting takes average of 20 days. The effect of covid-19 is positively correlated with the returns and significant ($p<0.05$).

Table 5. Results of NSE Banking

	Banking					
	Std			Skewed std		
Models	AIC	Half-Life	Persistence	AIC	Half-Life	Persistence
sGARCH(1,1)	-4.953219	-8.225464	1.0879209	-4.946755	-7.966655	1.0909033
gjrGARCH (1,1)	-4.947277	-7.488073	1.0969864	-4.940784	-7.338821	1.0990535
eGARCH (1,1)	-4.949498	11.857763	0.9432206	-4.943097	11.894102	0.9433890
apARCH(1,1)	-4.945765	NA	NA	-4.939431	NA	NA
iGARCH(1,1)	-4.956633	-Inf	1.0000000	-4.950104	-Inf	1.0000000
TGARCH(1,1)	-4.939225	12.750837	0.9470902	-4.932824	12.833706	0.9474227
NGARCH(1,1)	-4.952212	NA	NA	-4.945352	NA	NA
NAGARCH (1,1)	-4.950176	-7.353524	1.0988460	-4.943644	-7.378198	1.0984997
AVGARCH(1,1)	-4.918602	22.477988	0.9696339	-4.912585	24.508573	0.9721144

iGARCH(1,1) model has the least AIC value for both student t and skewed student t distribution. But with EGARCH (1,1) the model is stable while the mean reverting takes average of 12 days. The effect of covid-19 is positively correlated with the returns and not significant using the EGARCH (1,1) model.

Table 6. Results of NSE Consumer Goods

	Consumer goods					
	Std			Skewed std		
Models	AIC	Half-Life	Persistence	AIC	Half-Life	persistence
sGARCH(1,1)	-5.764543	-14.214268	1.0499727	-5.758081	-14.379034	1.0493862
gjrGARCH (1,1)	-5.758090	-14.067359	1.0505076	-5.751610	-14.259526	1.0498102
eGARCH (1,1)	-5.774400	10.903340	0.9384065	-5.768480	11.137049	0.9396593
apARCH(1,1)	-5.750216	-1.158048	1.8194753	-5.743754	-1.114669	1.8623544
iGARCH(1,1)	-5.769523	-Inf	1.0000000	-5.763061	-Inf	1.0000000
TGARCH(1,1)	-5.753324	14.029914	0.9517956	-5.746889	14.202949	0.9523687
NGARCH(1,1)	-5.756656	-1.625200	1.5318860	-5.749859	-1.291511	1.7103445
NAGARCH (1,1)	-5.759109	-13.832033	1.0513886	-5.752596	-13.716094	1.0518340
AVGARCH(1,1)	-5.746987	18.283307	0.9627982	-5.741949	12.201455	0.9447749

EGARCH(1,1) model has the least AIC value for both student t and skewed student t distribution. The model is stable while the mean reverting takes average of 11 days. The effect of covid-19 is negatively correlated with the returns and not significant using the EGARCH (1,1) model.

5. Conclusion and Recommendations

The results from the GARCH models revealed negative impact of COVID-19 on NSE Insurance, NSE Food, Beverages and Tobacco, NSE Banking and NSE Consumer goods stock returns (Ozili and Arun, 2020; Akanni and Gabriel, 2020; Adenomon et al. 2020) except NSE Oil and Gas returns which showed positive correlation with the COVID-19 Pandemic. This study recommends shareholders; investors and policy players in the Nigerian Stock exchange markets should be adequately prepared in form of diversification of investment in stocks that can withstand future possible crisis in the market.

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